Lecture 2

History of Science

History of Science

With science we mean physics, chemistry, biology (and mathematics)

We will describe some "revolutions"

The separate parts

- The Greeks
- The Renaissance
- The heliocentric worldview
- The scientific revolution
- Newton's mechanics
- Early botany and natural philosophy
- Chemistry

The separate parts II

- Geology and evolution
- The theory of relativity
- Quantum mechanics

The Greeks

Aristotle

The Greeks

- The first natural philosophy
- Advanced geometry
- Aristotle's mechanics
- and biology
- Ptolemaios describes the geocentrical worldview

The first revolution

Copernicus

The Renaissance

- The human body and the circulation of the blood
- Copernicus' heliocentrical worldview

The heliocentrical worldview

Kepler

The heliocentrical worldview

- Tycho Brahe makes observations. He describes his own worldview: The Earth is at the center of the Universe. The Sun orbits the Earth. The planets orbit the Sun.
- Kepler describes a new heliocentrical worldview where the planets move in ellipses.

The scientific revolution

Galilei

Descartes

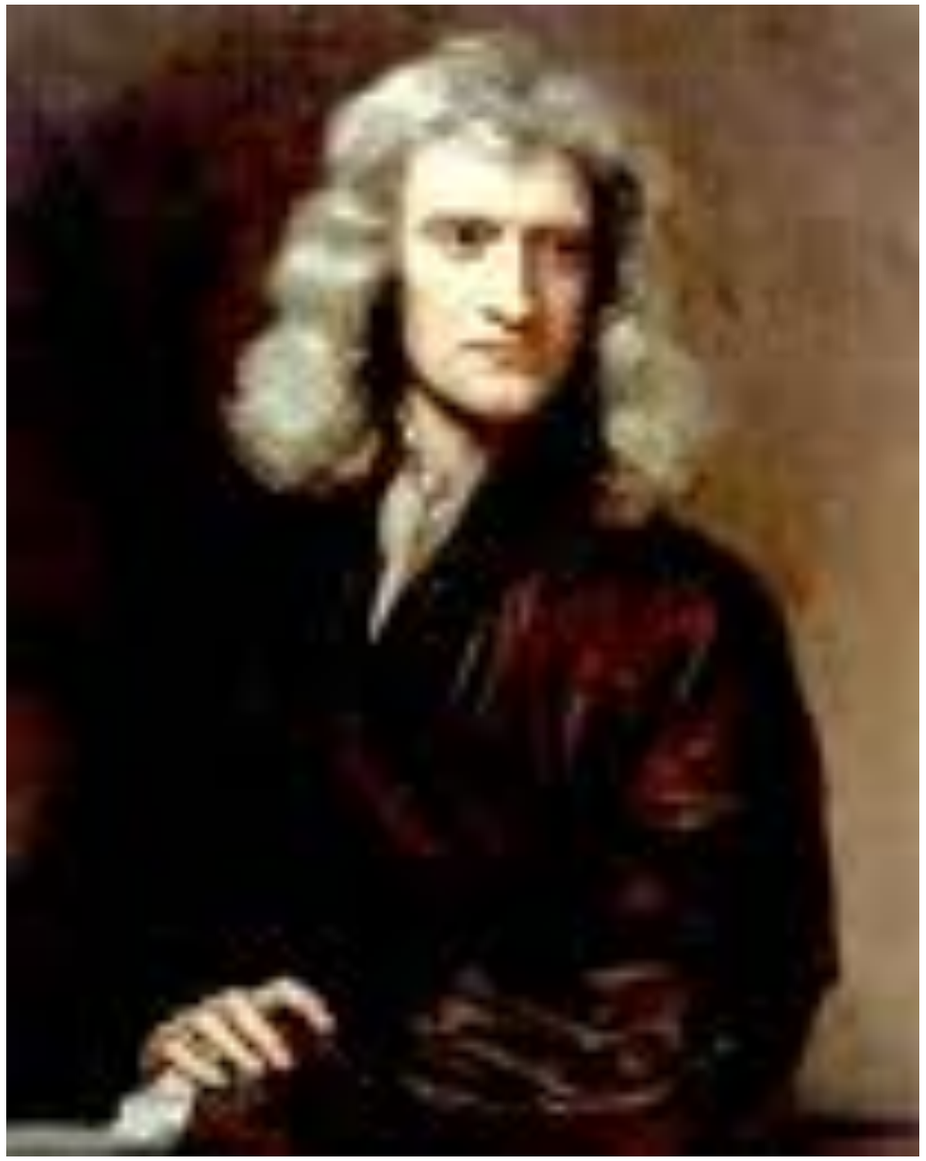
The scientific revolution

- Galileo Galilei makes experiments.
- He discovers a law for the movements of pendulums.
- Bodies with different weights fall equally fast.
- He constructs telescopes. He discovers mountains on the surface of the moon.
- and moons circling around Jupiter.
- and rings around Saturn.
- He becomes convinced by Copernicus' model.
- He gets punished by the church.

The scientific revolution II

- Descartes: ”Cogito, ergo sum" (I think, therefore I am)
- He creates a program for how research should be done.
- He presents a totally mechanistic worldview: Everything can be explained by interactions between physical bodies.
- He invents analytical geometry.

Newton's mechanics



Newton

Newton's mechanics

- At the age of 23 Newton formulates three mechanical laws and the law of gravitation.
- He develops the Calculus (Differential-and Integral Calculus).
- The calculus and his mechanics form the cornerstone in the first modern science.
- At the end of the 17th century Newton's mechanics is internationally recognized.
- Newton is perhaps the first really socially esteemed scientist.

Science established

- The Royal Society is established in England.
- Experiments are performed.
- Research on astronomy, gases and animals. Microscopes are used.
- Newton is at several times in conflict with the other scientists.
- Newton's optics.
- Conflict with Leibniz.

Chemistry

Scheele

Lavoisier

Chemistry

- Great steps are taken in the 18th century.
- At the beginning of the century almost nothing is known about atoms and chemical elements. There are only two known gases: Air and carbon dioxid.
- Oxygen is discovered. (Scheele/Priestley).
- Hydrogen is discovered (Cavendish). Man It is discovered that water is composed of hydrogen and oxygen.
- Lavoisier disproves the so called phlogiston theory of combustion.

Chemistry II

- John Dalton discovers the atom.
- Berzelius describes the composition of elements.
- He creates the modern chemical notation for substances.
- Mendeleyev creates the periodic table.

Early botany and natural philosophy

von Linné

Early botany and natural philosophy

- Botany becomes a science around mid 17th century.
- It is realized that species probably have *evolved.*
- and fossils seem to indicate that the Earth is probably much older than the Bible says.
- Carl von Linné: Describes the sexual system for the reproduction of plants.
- He creates a system of classification of species that is still in use.
- He places Man close to the apes in the system!
- He proposes a theory that says that the Earth is much older than previously believed and that it has once been totally covered with water.

Early botany and natural philosophy II

- There are continued speculations about the the age of the Earth.
- A model is created where it is assumed that the Earth has once breaked free from the Sun.
- At what rate is the Earth cooling down? An estimate shows that the Earth must be at least 75 000 years old. (A modern estimate is 4,5 billion years old, (miljarder in Swedish).)
- the first theories of evolution.
- Lamarck: Acquired properties can be inherited.

The second revolution: Geology and evolution

Lyell

Darwin

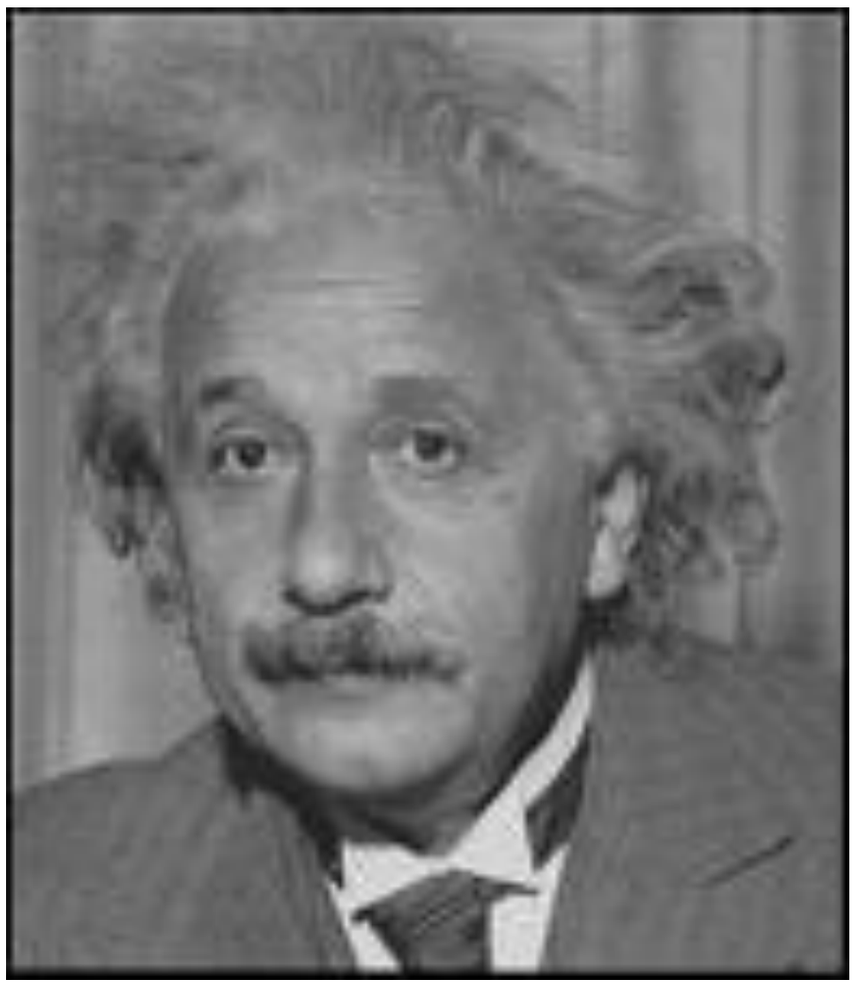
Geology and evolution

- Charles Lyell is considered the father of modern geology.
- He presents the thery of *uniformism* that says that the Earth has developed during a very long time by slow processes which are still at work today.
- Charles Darwin makes his famous journey with *Beagle* during the years 1831-1836.
- In 1859 he publishes *On the Origin of Species.*

Details

- During his trip Darwin becomes convinced the the species have developed.
- Other thinkers, for instance Lamarck, had already come to the same conclusion.
- Darwin found an explanation how and why they had evolved.
- *Natural Selection!*
- But objections where not late to arrive: For instance, a process governed by natural selection would take to much time.
- The discussion continues …

The third revolution



Einstein

The theory of relativity

- Around 1900 it is generally believed that it exists something called the *ether.*
- Experiments are done for measuring the *ether wind.* But no ether wind is detected!
- Einstein makes the assumption that the speed of light is constant in all moving systems.
- and from this he creates his Special Theory of Relativity in 1905.
- Simultaneity is a relative concept!

The theory of relativity II

- Lenght contraction.
- Time dilation.
- E=mc^2
- In 1915 Einstein publishes his General Theory of Relativity.
- The theory (in both forms) is a break with Newton's mechanics and worldview.

Quantum Mechanics

Schrödinger

Heisenberg

Dirac

Quantum Mechanics

- At the beginning of the 20th century, physicists have discovered several unexplained phenomena at atomary level.
- It seems as if electrons can be in two positions at the same time!
- It seems as if only a few energy levels are possible for the electrons.
- Bohr creates a model of the atom which tries to explain these phenomena.

Quantum Mechanics II

- In 1926 two more advanced theories are presented:
- Schrödinger's wave mechanics.
- Heisenberg's matrix mechanics.
- It turns out that the theories are equivalent.
- Dirac presents a unified mathematical formulation of Quantum Mechanics.
- and he predicts the existence of positrons.

Nobel Price!

Some later landmarks in science

- The Big Bang – teory in the 1940s.
- Crick and Watson's describes the DNA-molecule.
- String-theory.

Science!